CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY
MINING RESEARCH LABORATORIES

VIEWBEAP

AN ADVANCED 3-D GRAPHICAL REPRESENTATION PROGRAM FOR BEAP
(Windows Version 1.0)

by

Cube Systems Consulting Services Inc.
Ottawa, Ontario

June 1991

MICROMEDIA

Work on the project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy Mines and Resources Canada.

DSS File No. 009SQ.23440-9-9137
CANMET Project No. 23440-9-9139
CANMET Scientific Authority: Y. S. Yu

BEAP3D - BOUNDARY ELEMENT APPLICATION PACKAGE
FOR THREE-DIMENSIONAL ANALYSIS
OF MINE STRUCTURES
(Windows Version 1.0)

The BEAP3D system consists of three separate modules, namely: GENBEAP, BEAP and VIEWBEAP. The three User Manuals, published separately, are provided and listed below:

1 - **GENBEAP** - An Automated Graphical Data Generation Program for BEAP.

2 - **BEAP** - Boundary Element Analysis Program for Three-Dimensional Analysis of Mine Structures.

3 - **VIEWBEAP** - An Advanced 3-D Graphical Representation Program for BEAP.

HARDWARE REQUIREMENTS:

Minimum Configuration: a 386 based Dos computer with SVGA colour graphics monitor and adapter, 200 megabytes of hard disk, 8 megabytes of RAM.

Suggested Configuration: a 33 Mhz - 486 Dos computer with SVGA colour graphics monitor and adapter, 650 megabytes of hard disk, 16 megabytes of RAM.

Software Requirements: Microsoft Windows 3.0 user interface system.

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Reference to this manual should be quoted as follows: "VIEWBEAP - An Advanced Graphical Representation Program for BEAP (SUN version 1.0), MRL Report No. 91-032"

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1. GENERAL DESCRIPTION

1.1 ABOUT VIEWBEAP

ViewBeap is the result processing module for the three-dimensional boundary element analysis program BEAP. ViewBeap displays mine structures or 3-D boundary element models, checks input data graphically, facilitates the handling of bench mark stress/displacement calculations, and provides graphical representations of analytical results. The Windows version of ViewBeap was developed on an MS-DOS compatible computer, and requires the Microsoft Windows 3.0 User Interface.

The users of ViewBeap should be familiar with MS-DOS and Microsoft Windows before using the ViewBeap Postprocessor.

The ViewBeap program is designed so that navigation through the program is intuitive even for beginners. All of the program commands are organized in a series of icons.

1.2 ABOUT WINDOWS

Windows is a graphics interface developed by the Microsoft Corporation for computers using the MS-DOS operating system, i.e., IBM microcomputers and their clones. As the name suggests, individual windows are used to run independent application programs simultaneously. The use of windows and icons provides a more elegant interface which is quickly learned even by novice computer users.

Windows allows the user to integrate different tasks which are generally performed one at a time on your personal computer. Multiple applications can be brought into the workspace in the form of windows, which permit the transfer of information between these applications. It proves to be a great time saver, especially if you constantly switch between applications. With Windows you never have to exit a program in order to execute another.

In this way, Windows transforms your computer into a multi-tasking workstation which has sophisticated system functions and memory management capabilities. Although DOS does not allow true multi- tasking, Windows enables users to run multiple applications, especially if they were written to work within the Windows environment. Windows running under a computer equipped with an Intel386 processor or higher, go one step further to allow true multi-tasking for any program regardless of whether these programs were written for the specific environment or not.

One important advantage of the Windows environment is the fact that programs developed to run under it are completely device independent. This means that drivers for printers, plotters, and other peripherals need not be written individually for each application, because they are already provided by the Windows system. Hence, programs can be transferred from one computer to another without worrying about hardware compatibility provided that the computers can run Windows.

Another advantage is the fact that the Windows environment provides a standard interface for various application programs. This means that the command structure and screen layouts will be similar for diverse programs, so that minimal training will be required before even novice users become proficient at using a new program. Furthermore, the command options provided in various menu and dialogue boxes make the use of even sophisticated programs simple and intuitive.

1.3 DISCLAIMER

Extensive care has been taken during the development and testing of this program to ensure that the program source code and the underlying engineering principles comply with standard engineering practice. Should any discrepancies or possible program errors occur, they should be immediately reported to Energy Mines and Resources - CANMET Mining Research Laboratories.

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2. INSTALLATION

This section explains how to install ViewBeap on your computer and configure the operating environment. The objective is to get you up and running as quickly as possible.

ViewBeap is a program which operates under the Microsoft Windows environment. This means that if you already have Windows (Version 3.0 or higher) running on your computer, you can bypass the section entitled IF YOU DO NOT HAVE WINDOWS. If you don't have Windows, you must install the Windows first to execute ViewBeap.

The executable program is named as ViewBeap.EXE on your program disk. This disk also contains other files with the program such as help, reference text, and sample data files.

In this section the steps which you should follow are described. The commands which you are supposed to enter are shown underlined. Any keys which you have to press such as the **enter key** are placed in <...> quotes.

2.1 INSTALLATION STEPS

1. Check the contents of the ViewBeap package and the disks to make sure that you have all of the items.

2. Back up your distribution disk and store the original disk in a safe place.

3. Read the README.DOC. This file contains information about changes and additions to the software which may have occurred after the manual was printed.

4. Copy program disk into a directory.

CHECK THE CONTENTS

To do this place your disk into the diskette drive and from your DOS command line type:

```
DIR  A:  <Return>
```

The first chapter of this manual lists the items which should be contained in your ViewBeap package. If this list is modified after the manual has been printed, the changes will be listed in the README.DOC file on the distribution disks. If anything appears to be missing, please contact Energy Mines and Resources.

BACK UP THE DISKS

The ViewBeap distribution disk is not copy-protected. You should make working copies of the disk and store the original in a safe place, away from high temperatures, humidity, dust, and magnetic fields, before proceeding.

READ README.DOC

The README.DOC file on the SETUP disk contains any new or revised material that could not be included in the ViewBeap documentation before it went to press. You do not need to read all of the file at this time, but you should look carefully for any changes which may alter the installation procedures.

COPY PROGRAM FILES

The standard procedure is to create a directory on your hard disk where you wish ViewBeap to reside and to copy the contents of the ViewBeap disk into this directory. This is done as follows:

```
CD \          <Enter>
MD ViewBeap   <Enter>
CD ViewBeap   <Enter>
Copy A:*.*    C:\ViewBeap   <Enter>
```

IF YOU DO NOT HAVE WINDOWS

ViewBeap is a program which requires the Microsoft Windows environment and will not run without it. For this reason, if you do not already have Windows running on your computer, you must purchase and install Windows (3.0) first.

Windows takes approximately 3 MB of memory space on your hard disk, so you should check to make sure that this space is available before you proceed any further. You should also be aware of the computer hardware which you have, i.e., type of computer, monitor, pointing device, keyboard, and printer or plotter, because the Windows setup program will ask you questions regarding these devices. If you make a mistake during the setup procedure, such as selecting the wrong mouse or screen type, abort the installation and start over from the beginning.

The new Windows users should familiarize themselves with standard mouse operations and Windows procedures.

IF YOU HAVE WINDOWS

If you already have Windows, you can immediately start running ViewBeap. This can be done by:

CD VIEWBEAP <Enter>
WIN VIEWBEAP <Enter>

Following this ViewBeap will load and you will be ready to use the program.

A better way to use ViewBeap is by including the program icon into one of the folders displayed in the Program Manager of Windows.

When you start windows you will see the Program Manager window on the screen. This window is the section where most commonly accessed programs are grouped in folders.

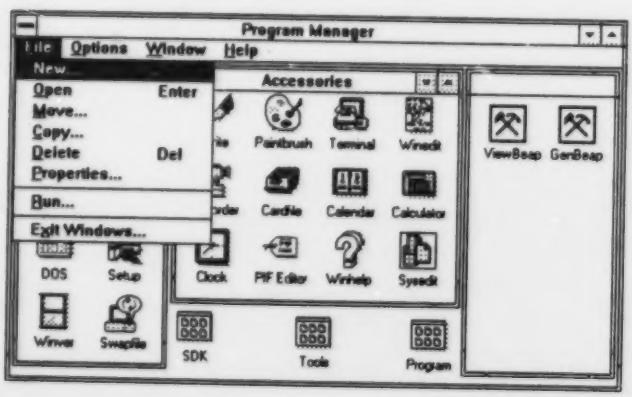


Fig 2.1 Windows Program Manager (Menu Option File New Activated)

To bring the ViewBeap icon into a Windows Folder you should select the **new** option under the **file** menu listed in the Program Manager window.

Following this, you will notice that a dialogue box will appear asking for the type of new operation. You should select the Program Group option.

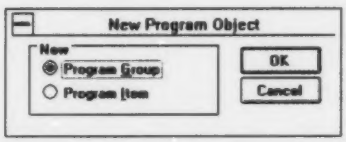


Fig 2.2 Selecting the type of file operation from the File Manager

You can name this group in any way you wish. In this case we have named our group as **VIEWBEAP**.

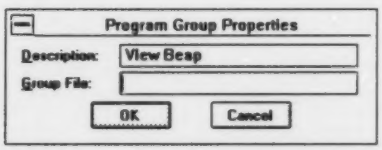


Fig 2.3 Selecting the name for a new folder

Following this an empty group box will appear inside the Program Manager window with the title which reads as "VIEWBEAP"

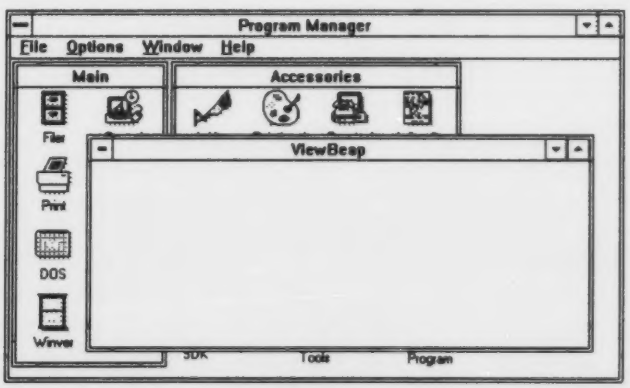


Fig 2.4 Creating the New folder for ViewBeap

The next procedure is to move the ViewBeap icon into this box. This can be achieved by selecting the **new** option from the **File** menu again. This time you should select **new file** from the selection list as shown inside the dialogue box. Following this a new dialogue box will appear as shown below:

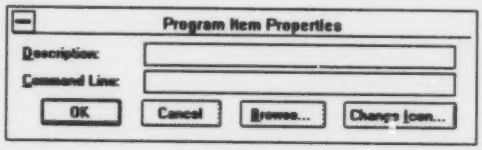


Fig 2.5 Defining the program item ViewBeap

The Description and the Command Line should be defined as shown in the illustration given above. For our example enter "ViewBeap" as the description. The Command line should list the full path and the name of the ViewBeap program as it was installed into your hard disk. Following this you should click on the OK button.

This will move the VIEWBEAP.EXE icon into the group box. Now you can execute ViewBeap from the windows folder. To do this you have to bring your mouse pointer on top of the ViewBeap icon and double click on the left mouse button. Double clicking is done by quickly pressing on the mouse button twice without moving the mouse. If you experience difficulties in doing this, the program can also be executed from the **Run** option listed under the **File** menu.

You are now ready to start using the ViewBeap program.

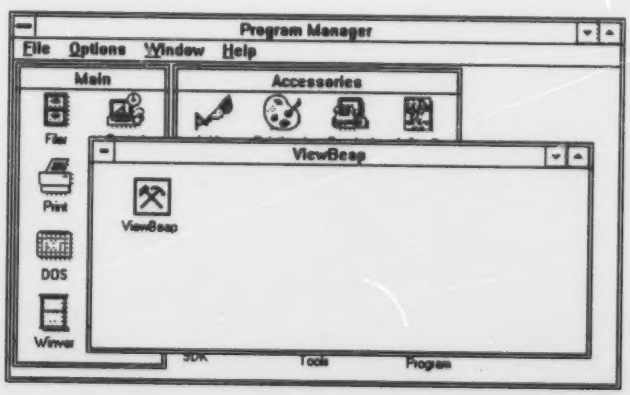


Fig 2.6 ViewBeap Icon ready to be activated from the windows folder

2.2 DATA FILES

In order to simplify the use of the system data files are organized in subdirectories. Each mine problem data should be saved under a subdirectory created specifically for the problem. The ViewBeap uses three subdirectories within the data directory. The problem geometry is defined in files in the problem directory with .DAT extensions. A standard configuration will be as follows:

PROBLEM : Directory name where the problem is defined

Geom1.dat	Geometry file
Geom2.dat	Geometry file
ELESOL:	Directory containing element data for the problem.
RESCUBE:	Directory containing analysis results from the solution.
ANIMATE:	Contains animation frames for later display

Each problem data directory should contain these subdirectories.

2.3 STARTING THE PROGRAM

If you have already installed the ViewBeap icon into the Windows Folder, you can start the program by double clicking on the icon show below.

Before using the program you should get yourself familiar with the Windows procedures. Knowing the basic windows functions such as how to use the mouse efficiently, double clicking, maximizing windows, minimizing windows and how to use the program manager are prerequisites to use the ViewBeap program. Since you have to install Windows prior to the installation of ViewBeap, we are assuming that you have a copy of Windows manuals.

If you have not used windows before, It is strongly recommended that you read the manuals provided to you in the Windows package.

3. MAIN WINDOW

3.1 FUNCTIONAL DEFINITIONS

The first window which shows up on the screen is referred to as the ViewBeap Main window. The components of this window is illustrated below:

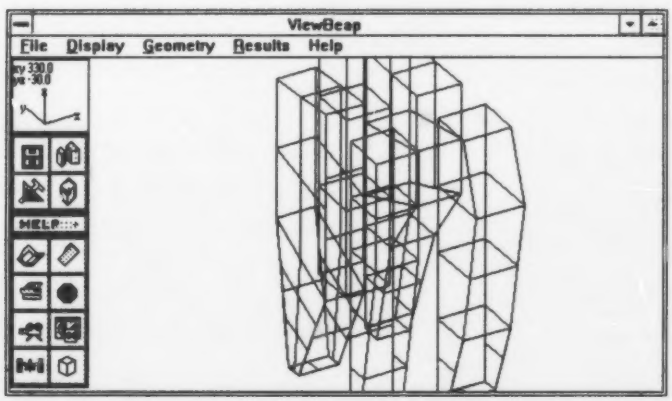


Fig 3.1 Components of the ViewBeap Main Window

The main menu contains four items that remain present throughout the run of the program. The bottom portion of the menu region is referred to as the submenu area. This section will change according to the main menu options selected by the user.

The graphics display area is the section where the mine geometry is displayed. Once the user completes the graphics related functions, the modified image will be displayed in this region.

3.2 HOW TO USE THE MENUS

ViewBeap has been developed to be user friendly and easy to use. To accomplish this, ViewBeap is designed around a simple and consistent menu system. All menu items appear as rectangular icons, neatly organized on the left hand side of all major windows. There are three different types of menu items:

* Activation Items -simply click on the item to perform its task.

* On/Off Items - click on the item to turn the feature on or off. The image on the item appears as not pressed down when off and pressed down when on.

* Choice Items - clicking on the item will activate the choice selection dialogue boxes. Optionally the user can click on the option button as listed in a dialogue box.

3.3 MENU STRUCTURE

The main menu area consists of four menu items which in turn activates various sub menu items. The four main items of the program are listed below:

DISPLAY MENU
The Display submenu allows the users to access different graphics, speed options, three-dimensional viewing and select shading types.

GEOMETRY DEFINITIONS MENU
The Geometry Definitions submenu enables the users to access the functions required to manipulate the image such as zooming, panning, or rotations.

FILE MENU
The File submenu allows the users to access various file operations such as saving, printing, creating animation sequences and activating the preprocessor.

RESULT MENU
The Result submenu allows the users to access functions which are used for displaying stresses, defining stress planes and parameters, etc.

3.4 PROGRAM MODULES

ViewBeap including the main window has 7 modules, each of which are loaded during the initial program execution. However not all of these modules are active. Although you can maximize the active windows using your mouse, this is not recommended. The recommended procedure is to activate the module window from the main window by clicking on the desired option to activate these windows. A list of the modules are given below:

SET COLOURS WINDOW

This window is used to paint regions with selected colours.

SET EYE WINDOW

This window is used to orient the perspective viewing paramaters.

HIDE EDIT WINDOW

This window is used to hide regions of the image.

RESULT CUBES WINDOW

This window is used to define result cubes.

RESULT PLANES WINDOW

This window is used to define result planes.

HIDE PLANES WINDOW

This window is used to hide result planes.

3.5 FILE MENU ITEMS

Once selected, the following sub menu items will be available to the user.

OPEN FILE

This menu item allows the user to open a new model. The user is prompted for the name of the directory that contains the problem set. The default directory is "." to signify the current directory.

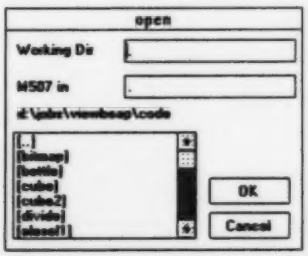


Fig 3.2 File Open Dialogue Box

FILE SAVE

This menu item should be used in order to save the changes made during a session. All of the editable data used by ViewBeap is stored in memory, therefore, the changes you made during a work session will not be saved unless this menu item is used.

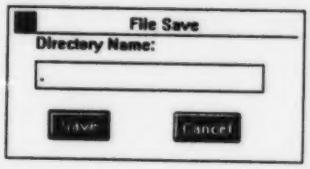


Fig 3.3 File Save Dialogue Box

PRINT

This option will allow the users to print the graphics image as displayed in the main window.

Usually printing takes a long time depending on the program or printing options selected. It is normal to expect 3-7 minutes for complicated diagrams to be processed.

You can cancel printing by clicking on the ABORT button.

Printer Selections can be done by selecting the SETUP option. Once activated, this function program will display the selection list dialogue box where you can to select printers which are already installed in your system during the Windows setup.

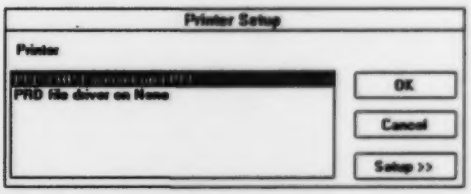


Fig 3.4 Printer Selection Dialogue Box

The printing options can be selected by clicking on the SETUP button located at the bottom right corner of the printer selection dialogue box.

When the setup dialogue box is activated, it will give you a list of a number of setup options available for your printer. These options will change depending on the type of printer connected to your system.

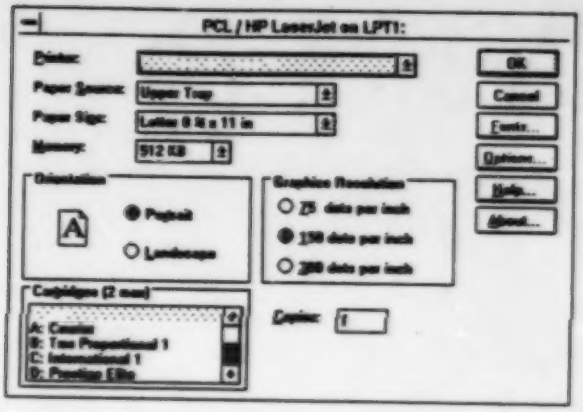


Fig 3.5 Printer Setup Dialogue Box

ANIMATE

Visualizing 3-dimensional geometry and results is a difficult task. It is often advantageous to move a scene about to get a real understanding of what you are looking at. ViewBeap's wire frame rendering has been designed to be reasonably responsive for real-time movement through a scene, however, displaying contours takes too long to be interactive. For this reason ViewBeap *includes an animation feature that will record images and then* allow fast playback. The animation feature is not intended to be a movie studio however it is often useful as a demonstration tool to familiarize people quickly with mine data.

Once this command is selected the animate options dialogue box will appear. The options listed in this box are as follows:

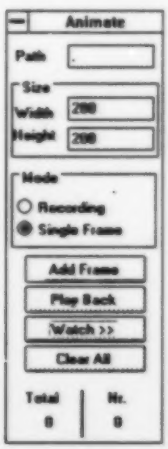


Fig 3.6 Animation Options Dialogue Box

PATH: Selects the path where animation sequences are stored.

SIZE: Defines the size of the graphics image as clipped from the main window. This also effects the size of the image files.

MODE: Animation sequences can be recorded in two ways:
- one by one frame storage
- using log files

In recording mode the images will be recorded in a log file format. Log files allow the user to pre-record the orientation of the scene in wireframe mode, change to the viewing mode that best suits the movie and then let the computer "crunch" for a while to produce the movie.

In Single Frame mode, you are allowed to take snap-shots of the image. To record frames one at a time, the user must: set the movie filename, set the width and height of the images and then press the Add Frame button every time the image in the main window is to be appended to the movie.

ADD FRAME:

Adds a single frame to the recorded sequence.

PLAY BACK:

Ends recording procedure and starts the generation of the actual images from the prerecorded log files.

WATCH: Activates the Watch window to view recorded frames.

In the **Manual** mode you can view frames by clicking on the < < or > > buttons.

In the **Automatic** mode you will view frames in the pre-recorded sequence automatically.

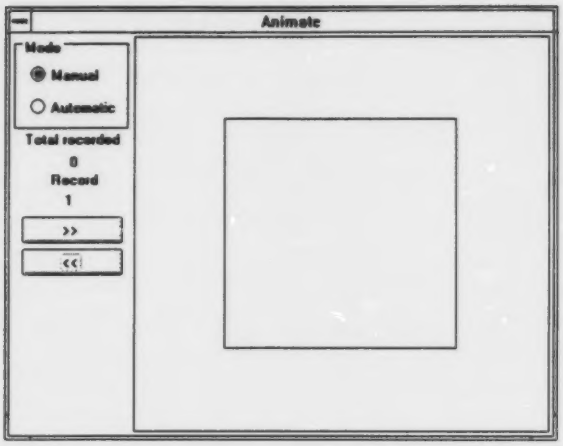


Fig 3.7 Animation Watch Dialogue Box

CLEAR ALL: Clears all images.

The following is a list of procedures illustrating the normal use of log files.

Procedures for log files:

To start a new log file

* clear the "Path" text field.
* select the "Size" .
* select the "Recording" mode.

To load an existing log file

* fill the "Path" text field with the desired path name.
* press the "Watch" button.

To save a log file

* fill the "Path" text field with the desired filename.
* repeat start new log file procedures.

To abort a log file

* press the "Clear All" text field.
* close the animation window.

To add the current orientation of the main window to the log file

* set the "Mode" choice to "Single Frame".
* press the "Add Frame" button.

To add the frames in the log file to the current movie

* set the "Frame width" and "Frame Height" text fields
* set the "path" text field
* ensure that the main window has the correct appearance (shading speed, image type, etc.).
* press the "Add Frame" button and wait until the number displayed at the bottom of the dialogue box reaches the number of frames.

Log files may also be edited using a text editor to perform more advanced animations.

AUXILIARY

The Auxiliary menu item is used to freeze and save a specific image inside an auxiliary window. This feature can be useful for comparing the active screen with another screen image processed earlier.

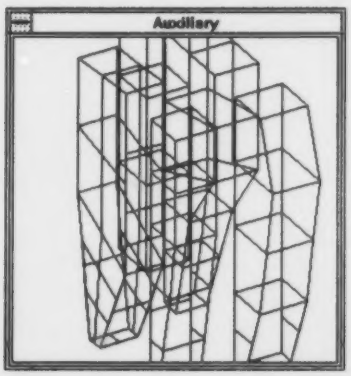


Fig 3.8 Auxilliary Display Dialogue Box.

CANMET

Work on the project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy Mines and Resources Canada.

DSS File No. 009SQ.23440-9-9137
CANMET Project No. 23440-9-9139
CANMET Scientific Authority: Y. S. Yu

CUBE

The ViewBeap post-processor was developed, under contract to CANMET, Energy Mines and Resources Canada, by Cube Systems Consulting Services Inc. Ottawa, Ontario, Canada.

3.6 DISPLAY MENU ITEMS

The Display sub-menu allows the user to access commands which will affect the appearance of the graphics image. The available menu items are listed below:

STEREOSCOPIC IMAGE

This menu item can be used to view the image in a three-dimensional stereoscopic manner. You must use the supplied 3-D glasses to be able to see this effect. When viewing complicated geometries, this menu item becomes an important tool to realize depth within the image.

Stereoscopic imaging does not work while displaying stresses. You should also note that, the clarity of the 3-D vision depends on the initial options selected from the dialogue box.

SHADING SPEED

The shading speed menu item has three choices:

* Fast graphics (rabbit mode)
* Slow graphics (turtle mode)
* Slower graphics (snail mode)

The ***fast graphics*** choice is primarily used to orient the model. Some approximations are made that may lead to visual errors in the image (the back of a stope showing through the front); however, the increase in speed allows for interactive movement. Once the user is satisfied with the final form of the image, a slower but more accurate representation for the model may be chosen. **Stress contours will not appear in fast mode.**

Slow graphics is usually sufficient for final images, but it can take up to 30 seconds for very complicated images. Hidden and intersecting faces appear properly. All stresss contours appear, however the shape of the contours may only be approximate.

The ***slower graphics*** choice produces the same results as the ***slow graphics*** except that special attention is given to the shape of stress contours. The time required for this mode can range from 1 to 2 times the time needed for slow graphics.

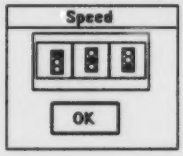


Fig 3.9 Speed Options Selection Box

IMAGE TYPE

The image type has four choices from which to select. These choices are:

* Wire frame
* Wire frame with numbers
* Solid colour coded
* Solid shaded

Wire frame is the default choice. Most of the movement related functions should be performed in this model, which is the most convenient and fastest mode in ViewBeap.

For reference purposes, it is possible to display the wire frame with numbering, i.e., element numbers and node numbers. The numbers in red correspond to the nodes while the numbers in black for the elements.

The solid colour coded choice is generally used to identify between different objects within the mine geometry. Initially all elements are coloured green. The Edit Element Colours menu item must be used to change the colour of the elements.

The fourth choice is solid shaded faces. The faces are coloured to give the appearance of a white light source emanating in a defined direction on green faces.

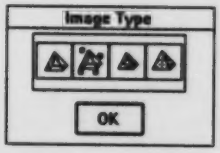
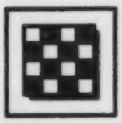


Fig 3.10 Image Type Selection Box.



EDIT COLOURS

When using the solid colour coded choice discussed above, it is necessary to change the colour of the faces. A separate window is used for this purpose and is discussed in Section 4. The menu item will activate this window.

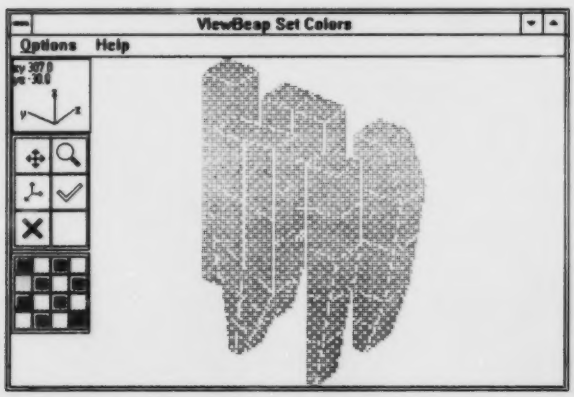


Fig 3.11 Edit Colours Window

LEGEND

This menu item will activate a text legend on the graphics screen which contains two user defined lines of text and other information detailing the current orientation, stresses displayed as well as any warnings the viewer should be aware of. The two user defined lines of text as well as the location of the text legend may be changed using the LEGEND DEFINITION menu item.

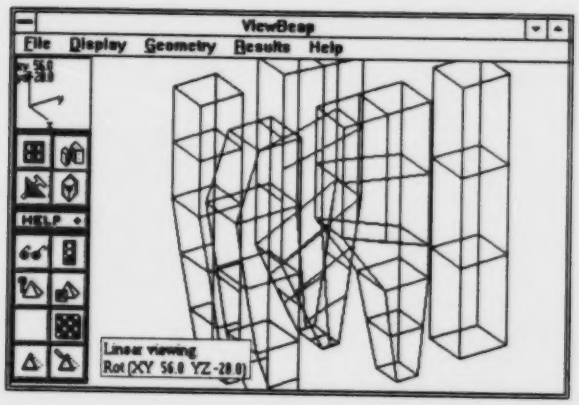


Fig 3.12 Main Display with Text Legend Box

HIDE

This menu item will remove any tagged hidden objects from the main and other windows. The objects can be tagged hidden using the HIDE EDIT menu item. This procedure can prove to be useful if the graphics image is too complex and the section to be displayed is a small portion of the overall geometry.

HIDE EDIT

This menu item will activate a new window where elements can be tagged as being hidden.

For more information on hiding elements see Section 5.

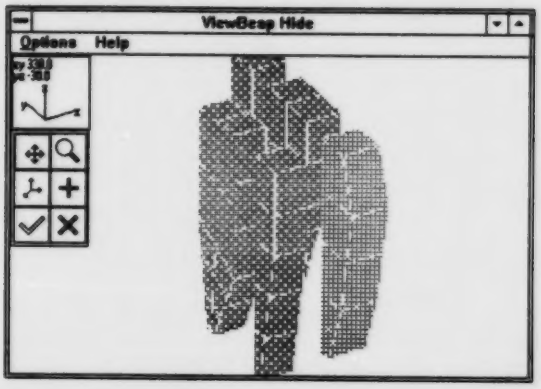


Fig 3.13 Hide Edit Window

3.7 GEOMETRY MENU ITEMS

The Geometry sub-menu contains menu items used to orient the model in the main window. Through this sub-menu you can access the following menu items:

ISOMETRIC VIEW

ViewBeap can project the image on the screen in one of two ways

* Isometric mode
* Perspective mode

In the isometric mode ViewBeap simply removes the depth from the scene giving a very rectangular appearance to the model. Isometric viewing is best suited for judging distances and seeing the model as a whole. The orientation of the view can be changed by: rotating, zooming and panning the image.

PERSPECTIVE VIEW

Using a perspective projection the viewer is placed within the model. Orienting the viewer becomes somewhat more complicated than in the isometric projection. The orientation of the view can be changed by: rotating, moving the eye position and moving the point of interest.

When the perspective mode is selected, you will notice an additional template which will be added to the menu area. This template is called perspective movement template, which will allow you to approach closer or away from the image. Also using this template you can move towards the top or bottom of the image as well.

The available movement options from this template is listed below:

NorthWest	North	North East	East
South East	South	South West	West
Up	Down		

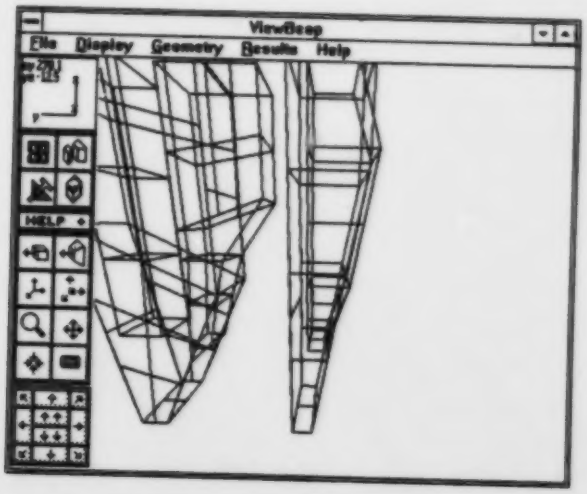


Fig 3.14 Image Displayed In the Perspective Mode.

ROTATE

This menu item will allow you to rotate the image. Rotations can be done by clicking the left mouse button inside the graphics image, and moving the mouse, to bring the object to the desired orientation, without releasing the left mouse button. Once the image is positioned in the way you require, you can release the mouse button. The image will then be displayed in the new rotated configuration.

ZOOM

This menu item can be used to zoom in and out of the graphics image. Zooming can be performed by selecting an area where you wish to zoom using the left mouse button. If you wish to zoom out you should use the same operation by using the right mouse button.

PAN

Moving the graphics image can be performed by selecting the pan menu item. When this menu item is selected you can move the mouse pointer inside the graphics area and click on a point of the image. The user then translates this point by dragging the mouse (without releasing the mouse button) to the new location. When the mouse is released, the entire image is redrawn with this translation.

RESET

This command can be used to reset the image to the original configuration. Since the original orientation will be lost after you manipulate the image, you may find this command useful in resetting all options and starting with a fresh image.

MEMORY

This informative command will enable you to see the amount of memory available for the graphics operations. Note that the graphics speed and the capacity of the program can be greatly enhanced by increasing the RAM memory in your system. ViewBeap is not limited to 640K space and will use as much memory as you have in your system.

For more information related to memory and performance, please refer to the Windows manual.

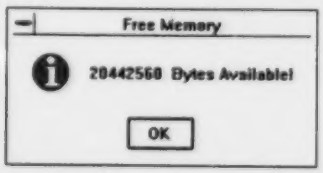


Fig 3.15 Free Memory Display Dialogue Box

SET EYE POSITION

This option is used to define the perspective view orientation. It will activate a window which will allow the user to graphically change the position of the viewer and the point of interest in the scene. For more information see Section 6.

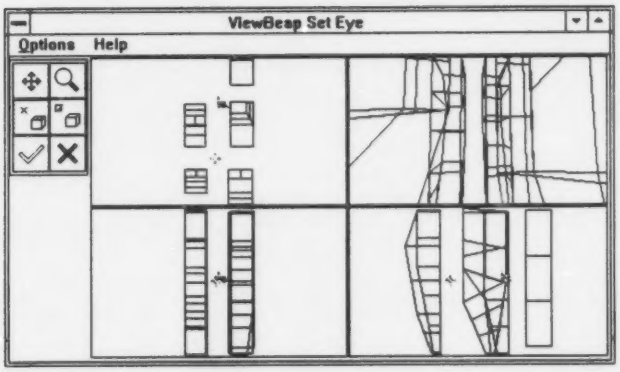


Fig 3.16 Set Eye Window

3.8 RESULT PROCESSING

The Result Processing sub-menu contains menu items related to the viewing of stress and displacements.

DEFINE RESULT CUBE

This menu item will activate a new window, where you will be provided the capability to define regions for which the results (stresses and displacements) are to be calculated by the DIVIDE program.

A detailed description of the Result Regions Definition window will be given in Section 7.

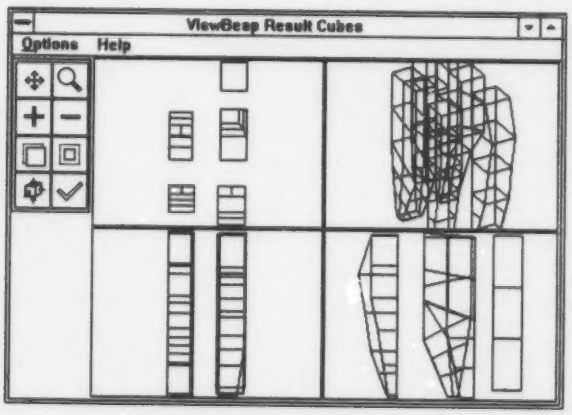


Fig 3.17 Result Cubes Window

DEFINE RESULT PLANES

This menu item will activate a new window from which to define result planes. These planes are the only means of viewing the results within the result cubes.

A detailed description of the Result Plane Definition Window is given in Section 8.

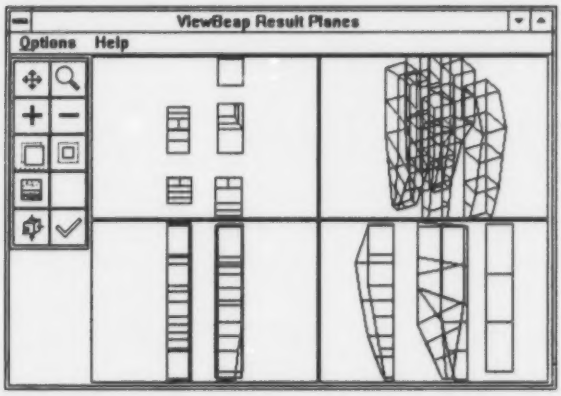


Fig 3.18 Result Planes Window

HIDE RESULT PLANES

This menu item is similar to the hide menu item in the Geometry menu. If the boundary element model is large and complex, it may be difficult to identify and interpret the results as they are displayed on the screen. Using hide menu item, you can turn off previously defined result planes and look at one or several of these planes at a time.

This menu item will create a new window which is referred to as the Hide Result Planes window. A detailed description of this window will be discussed in Section 9.

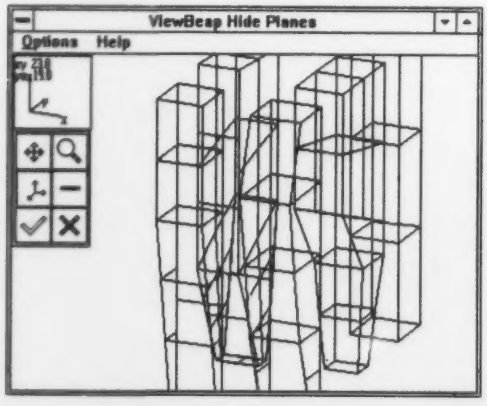


Fig 3.19 Hide Planes Window

DEFINE STRESS TYPE

This menu item is used to select the current stress type.

The available types of stresses and user-defined quantities are summarized below:

The stresses are normal stresses in X , Y, Z directions, shear stresses in XY, ZY, XZ planes, three orientations for the principal stresses and three user defined options. The user defined options does not have to be stresses or a combination of the stresses. Other useful analysis results such as error percentage, tolerance or other required quantities can also be defined. The decisions on these definitions should be done during the problem definition which is done prior to using the BEAP3D boundary analysis program solver.

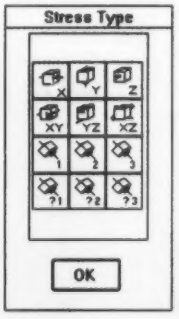


Fig 3.20 Stress Type Selection Box

LEGEND DEFINITION

Stress legend is used to define the stress levels and colours corresponding to the defined stress intervals as well as the appearance of stress and text legends.

The stress legend option will display a dialogue box where various options will be available to you. These options are listed below:

Type:

Defines the type of legends to pick from

* Automatic

  The legend ranges will be calculated automatically

* Max Min

  You will be required to enter the maximum and minimum values for legend calculations

* Manual

  You will be required to enter the list for the legend manually.

Scheme:

Defines the colour schemes to pick from.
There are two available options:

* Colour
* Black and White

Font Size:

Defines the size of fonts to be used in stress display.
There are three options:

* Small
* Medium
* Large

Location:

Defines the location for the stress legend to appear on the screen. There are 4 possible locations:

* Lower right
* Lower left
* Upper right
* Upper left

Colours:

Defines the colour grading. There are two options:

* From Blue to Red
* From Red to Blue

Legend Text:

Allows the user to enter the titles and captions for the legend. You will be given two lines for text entry.

Once the options are entered, you can click on the apply button to save the legend definitions. Note that the text legend can be turned on or off using the Legend command from the Display menu.

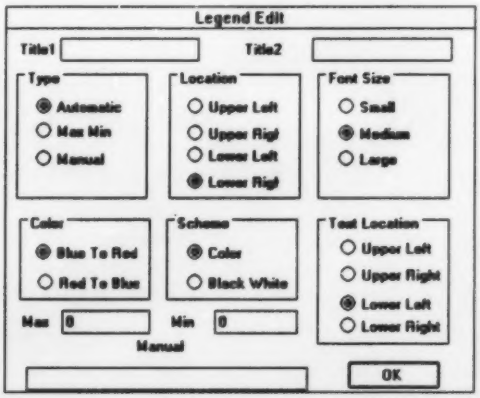


Fig 3.21 Legend Edit Options Dialogue Box

Once the options are set, the user can click on the apply button to invoke the changes to the legend definitions.

STRESS VIEW TYPE

Through this menu item the user can select the type of results to display. There are 6 options available:

* No stress display
* Conforming stress contours
* Non-conforming stress contours
* Stress display according to the center value.
* Deformed structure - solid coloured
* Non-conforming stress contours on the deformed structure.

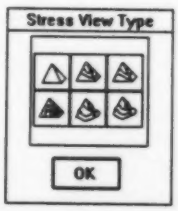


Fig 3.22 Stress View Type Dialogue Box

The procedure to use these options can be summarized as follows:

(1). Select the stress view type. The program will do the necessary calculations, and display the stresses (or displacements).

(2). Select the speed option. Each of the stress view types will perform different operations depending on the speed options chosen.

As an example, if you have selected the conforming stress contours and the slow mode, the stresses will be displayed as a single value for each element. If you now select the slow mode, the stress contours will be calculated between the elements and a more refined stress contour figure will be generated. Note also that the type of display will also depend on the Mesh Size as well as the speed type. Selecting a smaller mesh size will result in more accurate stress contour calculations.

The time required to calculate the stresses and display may differ depending on the options selected. The display speed also changes depending on the size of the window and the resolution of the graphics card. For a standard VGA card, slow mode and non conforming stresses may take as much as 60-70 seconds on a 20Mhz 386 computer. As an example, if you wish to select conforming stresses in the slow mode, you should first select the orientation of the geometry in the wire frame mode. This is the fastest way to orient your image. If you are satisfied with the image orientation, you should then select the solid colour model from your display. Next step is to select the conforming stresses option from the stress view type. Once the stresses are displayed, you should now select the graphics speed type. Although other combinations of commands can be used to achieve the same result, it is our opinion that the above stated order is the most convenient way to achieve this result.

DEFINE MESH SIZE

This menu item is used to define a scaling factor for the displacement display and the mesh size is used for displacements and non-conforming stress display. The following dialogue box will appear:

Fig 3.23 Edit Mesh Size Dialogue Box

MINING STEP NUMBER

The BEAP3D system allows the user to define multiple mining steps for a given model. This menu item is used to select one of the available mining steps for viewing. All geometries not pertaining to a given mining step will be hidden. The results will be reloaded for the new mining step.

Mining steps 1 through 10 are currently available. Mining step 1 is the default.

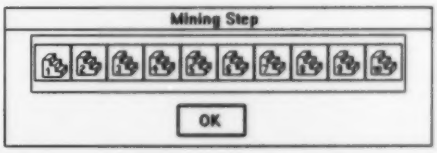


Fig 3.24 Mining Step Selection Dialogue Box

4. SET COLOR WINDOW

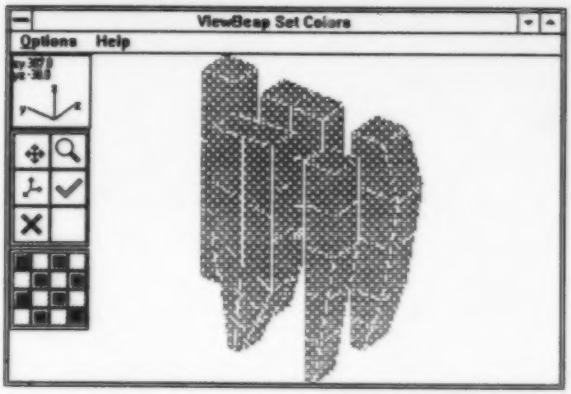


Fig: 4.1 Set Color Window

For identification reasons, it is often useful to colour code elements. These colours are only used by the main window when the image type is set to a solid colour code.

The colour pad menu item determines how selected elements will be coloured. The user should select elements by either:

- selecting individual elements by simply clicking on the elements or,
- selecting a group of elements by clicking and dragging a box that surrounds the elements.

MENU ITEMS

ROTATE

Rotate to improve visibility. See Previous Section for detailed description.

ZOOM

Zoom in or out to improve visibility. See Previous Section for detailed description.

PAN

Move to improve visibility. See Previous Section for detailed description.

OK

When all functions are completed you should use the OK menu item to close the window and accept the changes.

CANCEL

This menu item should be used to cancel the current operation and close the window.

5. EDIT HIDE WINDOW

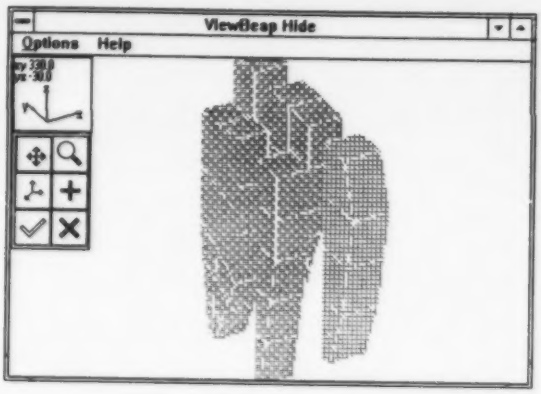


Figure 5.1 - Edit Hide Window

This window is used to hide elements of the graphics image to get a uncluttered picture of the region which you wish to work on. You may find this useful especially if the geometry of the problem is complicated.

In this window the elements to be hidden are coloured grey. When the OK menu item is selected these elements in all other windows will not be visible.

The hide(-)/unhide(+) menu item determines how selected elements will be affected. The user should select elements by either:

- selecting individual elements by simply clicking on the elements or,
- selecting a group of elements by clicking and dragging a box that surrounds the elements.

MENU ITEMS

ROTATE

Rotate to improve visibility. See Previous Section for detailed description.

ZOOM

Zoom in or out to improve visibility. See Previous Section for detailed description.

PAN

Move to improve visibility. See Previous Section for detailed description.

OK

When all functions are completed you should use the OK menu item to close the window and accept the changes.

CANCEL

This menu item should be used to cancel the current operation and close the window.

UNHIDE(+)

This menu item indicates the operation that would occur when elements are selected.

HIDE(-)

This menu item indicates the operation that would occur when elements are selected.

The procedure to hide regions is as follows. First you should toggle between the plus and minus icons. Minus means that you will be hiding selected regions and plus means that you will be un-hiding regions. Once you click on an option you should then move the mouse pointer into the graphics area and select a region. You can add or remove plate faces by clicking inside these faces as well. Once the selection is completed, the main display window will show the object with hidden sections removed from the display.

Note that the hidden section of the graphics image will NOT be removed from the data file.

6. SET EYE WINDOW

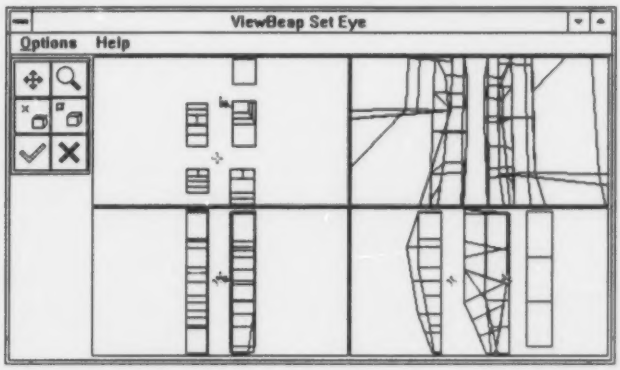


Figure 6.1 - Set Eye window

This window is used to set the eye location and eye destination for the perspective viewing mode. The eye location and eye destinations are illustrated by two icons, an eye and a cross respectively. By moving these in any of the three planar views, you will be able to change the display orientation. The new orientation will be displayed in the top right window.

MENU ITEMS

ZOOM

Zoom in or out to improve visibility. See Previous Section for detailed description.

PAN

Move to improve visibility. See Previous Section for detailed description.

SET EYE LOCATION

This menu item is used to select the viewers position. The user may then click and drag the eye icon to the desired location in one of the planar views. The resulting scene is animated in the fourth view.

SET EYE DESTINATION

This menu item is used to select the location that the viewer is looking at. The user may then click and drag the cross icon to the desired location in one of the planar views. The resulting scene is animated in the fourth view.

OK

When all functions are completed you should use the OK menu item to close the window and accept the changes.

CANCEL

This menu item should be used to cancel the current operation and close the window.

7. DEFINE RESULT CUBES WINDOW

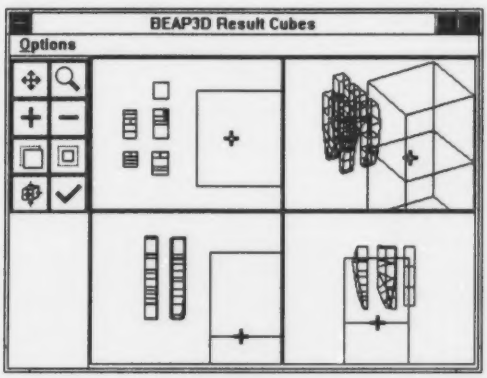


Figure 7.1 - Result Cubes Window

This window is used to define the regions for which volumetric stress calculations are to be performed. These regions (also called result regions or resultCubes) are represented by brick shaped objects in space that can be located and sized to encompass areas of interest. The regions can be overlapping if required but it is not suggested as this will increase the time required for finding the solution. The DIVIDE program, which is discussed in Section 10.5, is used to fill the result cubes with data. The reader should take some time to become familiar with the workings of DIVIDE because of its importance to viewing volumetric stress in VIEWBEAP.

Each result region is shown in the views as a red block with an identification number in the lower left corner. The three views labelled XY, XZ and YZ are used to graphically manipulate the regions while the fourth view shows a three-dimensional look at the regions to give the user a better feel for the orientation of the regions.

Each result region has an individual set of parameters that describe the size and shape of the region, the criteria required for finding its data and indicators to show the extent of the solution. The dialogue box below will appear during various operations to change these parameters. The information will belong to the region that was most recently selected. The user may select a region for inspection at any time by simply clicking on the image of the region in one of the views. The apply button must be pressed to keep any changes that were made in the dialogue box.

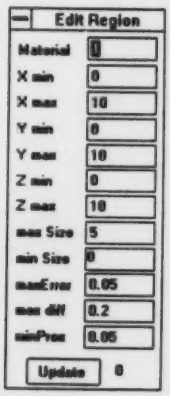


Fig 7.2 Edit Result Cube Regions Option Selection Dialogue Box

The entries in the dialogue box can be defined as follows:

Material:	Defines the type of material for the region.
X min/ Xmax:	Defines the minimum and maximum X coordinate values for the result cube.
Y min/Ymax:	Defines the minimum and maximum Y coordinate values for the result cube.
Z min/Zmax:	Defines the minimum and maximum Z coordinate values for the result cube.
Max size:	Size Parameter for the Divide Program.
Min size:	Size Parameter for the Divide Program.
max Error:	Error tolerance parameter for the Divide Program.
max diff:	Parameter for the Divide Program.
min prox:	Parameter to define valid proximity value for Divide Program.

MENU ITEMS

The following menu items are available to manipulate the views and result regions.

ZOOM

Zoom in or out to improve visibility. See Previous Section for detailed description.

PAN

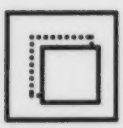
Move to improve visibility. See Previous Section for detailed description.

CREATE A RESULT CUBE

A new result cube is created in the center of the model with an appropriate size and parameters for further modification. The information dialogue box reflects the new cube.

DELETE A RESULT CUBE

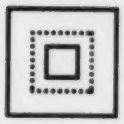
The user is prompted to click on the cube that is to be deleted with the left mouse button. The center mouse button will cancel the operation.



MOVE A RESULT CUBE

This option should be used to move the result cubes. The operation is done by clicking on the result cube and dragging it into a new location.

When you select the cube, a dialogue box will also appear. The result cube can be moved by entering the new location coordinates into the dialogue box.



SIZE A RESULT CUBE

This option should be used to re-size the result cubes. The procedure is to click on the result cube from a corner and drag the corner until the desired size is achieved.

When you select the cube, a dialogue box will also appear. The result cube can be sized by entering the new location coordinates into the dialogue box.

SHOW STRESS AT A POINT

This menu item will activate a dialogue box which lists various stress information related to a specified point within the result cube.

The point for which the stresses will be calculated is indicated with a red + icon. This location can be changed by dragging the icon to the new point. When you are satisfied with the location of the point you can Click on the Find Stress button as displayed in the dialogue box. This will activate the Beap Solver and calculate stresses for that point. When the results become available you can then click on the Cube or M507 options to display the stresses.

For more information on how to use Divide or M507 programs to calculate stresses see Section 10.7.

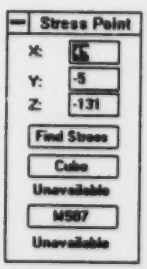


Fig 7.3 Stress Point Definition Dialogue Box

OK

When all functions are completed you should use the OK menu item to close the window and accept the changes.

8. DEFINE RESULT PLANES WINDOW

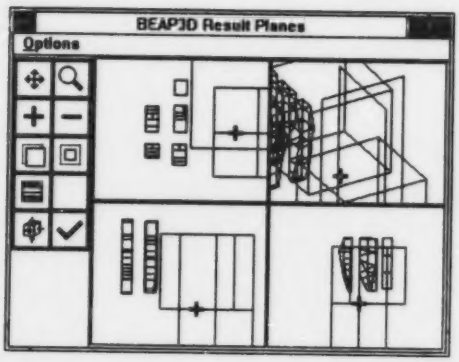


Figure 8.1 - Result Planes Window

This window is used to define planes for stress display. The defined planes will cut the result cubes and stresses on the surface of the planes will be displayed. The result planes can have height, width and thickness producing six-sided bricks. Separate sub-divisioning values are available for the three dimensions to set the required grid spacing.

The result planes in the window can easily be identified by green lines. If you wish to hide some of these planes for viewing convenience, you should activate the Hide Planes Window as described later.

You can also get detailed information related to the result plane. This can be performed by clicking on the result plane region for which you wish to get information. A dialogue box will appear listing information relevant to the selected result plane.

The entries in the dialogue box can be defined as follows:

X loc:	Defines X coordinate location for the plane centre.
Y loc:	Defines Y coordinate location for the plane centre.
Z loc:	Defines Z coordinate location for the plane centre.
Width:	Plane Width.

Height:	Plane Height.
Thickness:	Plane Thickness.
XY Rotation:	Defines the XY inclination for the plane.
XZ Rotation:	Defines the XZ inclination for the plane.
YZ Rotation:	Defines the YZ inclination for the plane.
X subdivision:	Defines number of element subdivisons in the X direction.
Y subdivision:	Defines number of element subdivisons in the Y direction.
Z subdivision:	Defines number of element subdivisons in the Z direction.

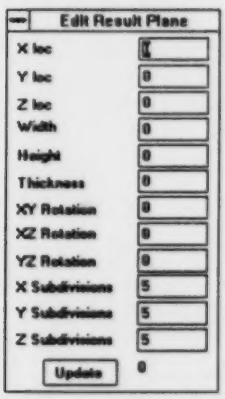


Figure 8.2 - Detailed stress information for result planes

MENU ITEMS

ZOOM

Zoom in or out to improve visibility. See Previous Section for detailed description.

PAN

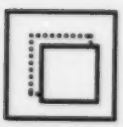
Move to improve visibility. See Previous Section for detailed description.

CREATE A RESULT PLANE

These menu items should be selected when the user is going to define a new result plane.

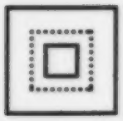
DELETE A RESULT PLANE

This menu item should be selected when you wish to delete an existing result plane. Stress calculations will not be displayed for deleted result planes.



MOVE A RESULT PLANE

A result plane can be moved graphically in any of the XY, XZ or YZ views. The user is prompted to click and drag a plane to the required location with the left mouse button. The center mouse button will cancel the operation before and during dragging. The information dialogue box dynamically reflects the altered plane and the apply button is automatically invoked when done.



SIZE A RESULT PLANE

A result plane can be sized graphically in any of the XY, XZ or YZ views. The user is prompted to click on and drag out the shape of a plane with the left mouse button. The center mouse button will cancel the operation before and during dragging. The information dialogue box dynamically reflects the altered plane and the apply button is automatically invoked when done.

SHOW STRESS POINT

This menu item will activate a dialogue box which lists various stress information related to a point within the result plane. Initially you will be required to select the stress type from a stress type selection dialogue box.

For more information see Section 10.7.3.

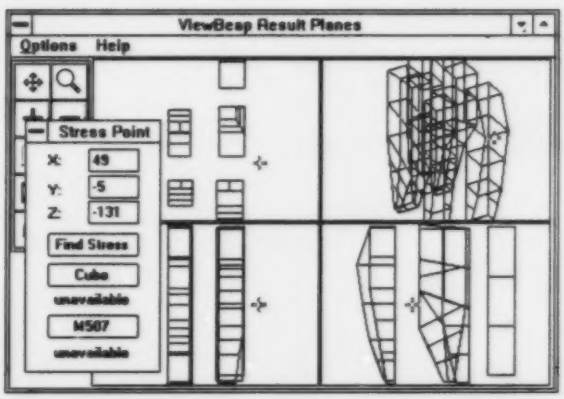


Fig 8.2 Show Planar Stress Points

SHOW MAX MIN VALUES

This menu item is used to print the maximum and minimum stress values for the selected stress type. These values are printed on the graphics image for your convenience. If you wish to see these values clearly you can zoom into a region until the text does not overlap.

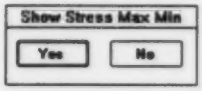


Fig 8.3 Show Stress Cancel Dialogue Box

OK

When all functions are completed you should use the OK menu item to close the window and accept the changes.

9. HIDE PLANES WINDOW

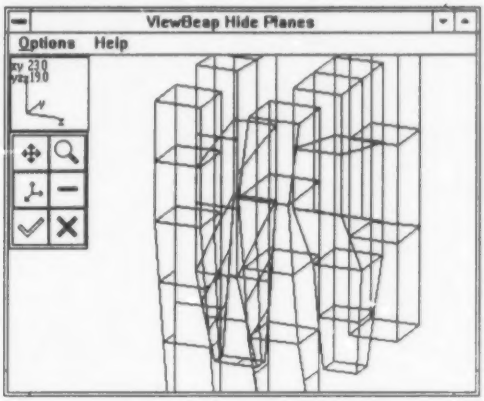


Figure 9.1 - Hide Planes Window

This window is used to hide result planes defined using the result planes window. You may find this useful especially if the geometry of the problem is complicated and you wish to see the stresses for a specific result plane only. This menu item will not delete the previously defined result planes, but simply hide them from the display.

In this window the planes to be hidden are coloured grey. When the OK menu item is selected the planes in the main window will not be visible.

The hide(-)/unhide(+) menu item determines how selected planes will be affected. The user should select result planes by either:

- selecting individual planes by simply clicking on the planes or,
- selecting a group of planes by clicking and dragging a box that surrounds the planes.

MENU ITEMS

ROTATE

Rotate to improve visibility. See Previous Section for detailed description. (Page 34)

ZOOM

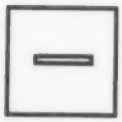
Zoom in or out to improve visibility. See Previous Section for detailed description. (Page 34)

PAN

Move to improve visibility. See Previous Section for detailed description. (Page 34)

UNHIDE(+)

This menu item indicates the operation that would occur when elements are selected.



HIDE(-)

This menu item indicates the operation that would occur when elements are selected.

The procedure to hide regions is as follows. First you should toggle between the plus and minus icons. Minus means that you will be hiding selected regions and plus means that you will be un-hiding regions. Once you click on an option you should then move the mouse pointer into the graphics area and select a region. You can add or remove plate faces by clicking inside these faces as well. Once the selection is completed, the main display window will show the object with hidden sections removed from the display.

Note that the hidden section of the graphics image will NOT be removed from the data file.

OK

When all functions are completed you should use the OK menu item to close the window and accept the changes.

CANCEL

This menu item should be used to cancel the current operation and close the window.

10. TECHNICAL DESCRIPTIONS

10.1 DESCRIPTION OF THE SYSTEM

ViewBeap, the post-processor for the boundary element analysis program BEAP, represents the state-of-the-art in graphics software design in present day computer systems. The graphics system compliments the analysis program, which provides the users an excellent display of the mine model for analysis and visual representations of the analytical results. This provides an useful tool for use by mining engineers in mine planning and ground control.

10.2 DESIGN PLATFORM

The program was developed using an MS-DOS computer with 4 megabytes of RAM and 80 megabytes of hard disk storage with a graphics subsystem using a 16" colour monitor.

The system was simultaneously developed in two environments. OpenWindows for Sun computers and Microsoft Windows 3.0 for MS-DOS based computers. The program was entirely written in C and the coding was designed and grouped in such a way that easy porting can be possible to other environments.

10.3 GRAPHICS SPEED CONSIDERATIONS

The graphics system was designed to use the following display modes:

Fast Mode (rabbit mode): This is very fast. It is used for preliminary viewing and positioning the model.

Slow Mode (turtle mode): This is considerably slower than the rabbit mode. It is used for drawing contours and showing plate intersections, this however, may not be entirely accurate.

Slower Mode (snail mode): This can take as much as double the time as the turtle mode, however, it gives completely accurate results.

10.4 BEAP DATA FILES

The BEAP3D system requires that each model (sometimes called a data set) have its own directory to contain the required files. There are numerous files used by the BEAP3D system, however, only a few are used by ViewBeap. The files used by ViewBeap are:

geom1.dat	- the principle geometry file
geom2.dat	- element information file
elesol	- element surface results
rescube	- result region geometry file
resultCube	- result region results file

ViewBeap may also create at the users request several other types of files. The location of these files will be under a subdirectory within the directory that contains the geometry files. Therefore, the user may be prompted to enter the full name of the file in such cases. The circumstances where the user will be asked for full file names are listed below:

* Printing - if printing is done to files.
* Animation movie file - see **note** below.
* Animation log file

Note: although the list of frames used in the animation is saved in this file, the actual images are always stored in a "animate" directory. This directory is created if not already present.

10.5 DIVIDE PROGRAM

To be able to represent contours inside the rock mass, the user will have to define two graphic entities required by **VIEWBEAP**; a ***ResultCube*** and a ***ResultPlane***.

The Divide program is a separate module which runs in conjunction with VIEWBEAP. To invoke the program click on the **DIVIDE** icon. While running, Divide can operate in the background allowing the user to work on other files or programs in Windows concurrently.

You should also make sure that you are logged into the problem data directory and the directory contains a sub directory named BE where all *.BE files reside.

10.5.1 DEFINITION OF RESULT CUBE

A ResultCube is a 3-D Block which is defined by the three coordinates axes. The (block) can contain only one sub-region type. A companion program of **VIEWBEAP**, **DIVIDE**, will be called and to decide where benchmarks have be computed to represent stress contours at the level of accuracy requested by the **VIEWBEAP** user. For this purpose **DIVIDE** recursively sub-divides the initial cube or block into 8 sub-cubes (each containing 8 benchmark locations) until sub-cubes are totally inside or outside an excavation, or until the level of accuracy has been reached . The level of accuracy is set by giving proper values to the following variables defined for each ResultCube.

- **Minimum level of Cube sub-division:**
  DIVIDE will sub-divide the ResultCube based on the minimum level using octree sub-division even if acceptable accuracy has been reached. The user should define this level of sub-division to ensure that an excavation will not be entirely contained within one of the resulting sub-cubes.

- **Maximum level of sub-division:**
  DIVIDE will stop the sub-division of the ResultCube when the maximum level is reached even if accuracy has not been attained, or even if part of some sub-cubes are still inside the excavation. Warning: if the maximum level is too high it can lead to unacceptable computation times.

- **Maximum error:**
  DIVIDE will continue to sub-divide based on the following test: interpolation is performed at the centre of the sub-cubes. The interpolated value is compared to a computed value, and

if the difference between the two is higher than the specified maximum error, the sub-division will continue.

- **Maximum difference**
  This parameter specifies the ratio between the maximum and minimum stresses for each component of stresses found inside a cell or sub-cube (xmx-xmn), and the maximum and minimum stresses for the same component of stress found across the entire Resultcube (xmax-xmin). Suppose the maximum difference mxdif = 0.2, then if

  (xmx - xmn)/(xmax - xmin) $\geq$ mxdif, the cell in sub-cubes will be sub-divided until
  (xmx -xmn)/(xmax - xmin) $\leq$ mxdif.

  For example, if the range of the major principal stress found across the entire Resultcube is 10, and the maximum difference is specified as 0.2, a cell within the resultcube will be further divided until the range of the major principal stress found inside the cell is less than or equal to 2, ie. 2/10 = 0.2.

  For most cases, this parameter should be set to 1.0 to deactivate this feature

- **Minimum proximity ratio:**
  Sometimes the solution gives inaccurate results for benchmarks computed too close to an element. **DIVIDE** will consider a benchmark invalid if located at the distance smaller than the minimum proximity ratio multiplied by the largest dimension of the closest element. Tests performed on BEAP have shown that optimal values for this parameter are between 0.05 and 0.2. A very small value can display inaccurate results for locations too close to the element surface.

When computing a resultCube, **DIVIDE** will place, by default, the maximum error found in the user defined field #2 of the stress component menu. The same level of sub-division reached will be used in the user-defined field #3. This is only true if no user-defined program has been initiated in the command line for user-defined fields 2 and 3. (see more about user-defined fields)

Module **M507W** is used in conjunction with module **DIVIDE** to calculate stresses inside a ResultCube or in conjunction with the post-processor to define interactively the location of the benchmarks.

The ResultCube for mining step 1 can be computed by running **DIVIDE**:

All commands for running **DIVIDE** are selected from the **Options** menu

To compute step 1 in the divide module:
Click on **Open**;
Select the file you wish to run, click on **Run**.

You may change the parameters of your file before running **DIVIDE**:
Select **Parameters** from the Option menu;
In the Parameters **Options** dialog box you may change the parameters by typing the new information in the field you wish to change.

10.5.2 DEFINITION OF A RESULTPLANE

When a ResultCube has been processed by **DIVIDE** a user can define a ResultPlane located inside the ResultCube for the display of stress contours. The stresses or user-defined values will be displayed on the surface of the ResultPlane(s). ResultPlanes created by **VIEWBEAP** could be saved for a future session by using the save file command of **VIEWBEAP**.

Users can find more information about the ResultPlane in the *DEFINE ResultPlane Window* section of the **VIEWBEAP** user's manual.

10.5.3 USER-DEFINED FIELDS

A user-defined program, **coulomb**, has been created to perform one of the user-defined functions. This program reads in a file called coulomb.dat, and calculates the factor of safety according to the Mohr-coulomb failure criteria. This file has the following format:

Mat_number, coh, frict

.

.

0.0,0

where

- *Mat_number* is the region number of a model where the calculation is to be performed;
- *coh* is the cohesion of material for the specified region; the unit used in the analysis should be consistent.
- *frict* is the friction angle in degrees.

The source for this program is given in the file coulomb.f. This provides an example for the user to create additional programs to evaluate other user-defined values such as safety factors based on the Hoek/Brown empirical failure criterion.

The command required to call this program for specifying user-defined field 1 and for the mining step 2 in a ResultCube which has already been computed by **M507W** is :

path\divide -s2 -1 *path*/coulomb ResultCube0

where

-s2	mining step number 2
-1	user-defined field #1
coulomb	user-defined program to calculate the factor of safety based on Mohr-Coulomb failure criterion.
	ResultCube0 user-specified 3-D block containing the results

Notes:

* in the current version no program has been created to represent user-defined field on the element.

* computation of user-defined field can be performed in the same time when the stress computation is done by **M507W**

10.6 KNOWN LOSS OF PRECISION

Loss of precision occurs when improper handling of the event where parts of a result region are inside and outside of an excavation and the maximum level is reached. Currently, the program assigns the stress value of the closest face to the interior points thus causing confusion at the element faces.

10.7 STRESS REPRESENTATIONS

Visual representation of the intensity of the stress on elements of the constructed model constitutes the main function of ViewBeap. All interpolation refers to linear interpolation between points of known stress. Linear interpolation is used in determining the stress contours between points of known stress within a region.

There are three different methods for representing stress within VIEWBEAP: element stresses, planar stresses and point stresses.

10.7.1 ELEMENT STRESS REPRESENTATION

Given the data from the "elesol" file, which contains 9 stress values and 3 user-defined quantities for each function node of the element the level of stress is displayed directly on the face of an element.

Points generated in the "elesol" file may be either 1/6 or 1/10 of the way from the boundary of the element. Interpolation naturally takes this into account obtaining from the libCode attribute in the *geom2.dat* file. There are basically three types of element stress representations:

Non-Conforming: Using all of the function nodes, the stress is "painted" over a mesh representing the element. The mesh size is user definable.

Conforming: The stress level for each node on the boundary of an element is determined by averaging the center values of all adjacent elements. The element is then painted to show the resulting contours.

Center Value: The element is simply painted with an appropriate colour to indicate the level of stress at the center of the element.

10.7.2 PLANAR STRESS REPRESENTATION

Viewing stress within a 3-dimensional object requires special consideration. VIEWBEAP uses "result regions" and "result planes" to view stress on planar surfaces within a volume of material. The result regions are volumes for which the stress levels within have been obtained. The determination of these results is somewhat complicated and discussed in more detail for the DIVIDE program. The result planes are rectangular surfaces located within one or more result regions. The stress levels on these planes are determined by interpolating the available data for the result regions. For more information on how to create and view result regions and result planes, refer to Sections 7 thru 9.

10.7.3 POINT STRESS REPRESENTATION

The following section discusses the procedure to find the level of stress at a specific point within the model. Point stresses can be found from within the Result Regions and Result Planes Windows (Sections 7 and 8). Activating the feature will produce a set of red cross-hairs as well as the following dialogue box:

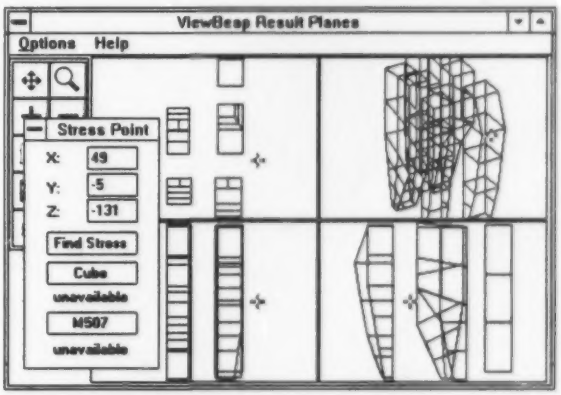


Figure 10.1 - Calculating Stress for a Specified Point

The cross-hairs will indicate graphically the point to be considered.

There are two options available for the user to find the stresses at a specified point in a boundary element model. If a result region for the model exists, then the stresses at the specified point will be interpolated using the existing stress information. As well, the stresses at the specified point will be calculated by the

M507 module, providing this module was activated when the user started the program (refer to Section 2).

The following procedure is suggested for the user to find the stresses at a specified point:

* Move the mouse pointer to a location on the screen where the user wishes to have the stresses calculated,
* Click on the point and drag the mouse (without releasing the mouse the button); the x, y and z coordinates on the dialogue box will change while you drag the mouse; release the mouse button if you are satisfied with the location (coordinates) shown in the dialogue box,

  - or -

  the user can directly edit the coordinates which appear in the dialogue box,
* Click on the **find stress** button.

If the result cube is available the detailed stress information for the specified point will be displayed at the lower portion of the dialogue box. The user can scroll various values by toggle on the scroll bar.

As mentioned above, if the module M507 has been activated the stress values will appear as well.

10.8 STEREOSCOPIC VISION

The Stereoscopic vision technique is a known concept in the motion picture industry. However, implementation of the method in the software applications was not available. The mathematical implementation of the concept is straightforward. It is based on separating the image into two; each having one chromatic colour. For the implementation of VIEWBEAP these colours were selected to be Cyan and Red. A pair of filtering glasses which filter out all but one of the colours for each eye, allows the user to see different images in each eye.

The stereoscopic vision technique work for both solid and wireframe images. This option will not work for stress contours due to the monochromatic nature of the technique.

APPENDIX A

Example Run

The following provides a procedure for the user to run an example:

* Create a directory and copy over the data file

* Copy over the file *.be from Beap directory

* Run successively the following modules:
  M101 by typing : path\m101.e
  M201 by typing : path\m201.e
  M203 by typing : path\m203.e
  M401 by typing : path\m401.e
  M501 by typing : path\m501.e
  M502 by typing : path\m502.e
  M503 by typing : path\m503.e
  M504 by typing : path\m504.e
  M205 by typing : path\m205.e

* Run VIEWBEAP
  - display the result (stresses and displacements on the elements.
  - define one or more ResultCube.

* Run 'divide' for ResultCubes for each mining step.

* Run VIEWBEAP again to define ResultPlane(s) and to display results on the specified plane(s).The primary purpose of the routines are to geometrically subdivide a user-specified 3-D space for a 3-D boundary element model for the purpose of defining where stresses and displacements should be calculated. This is referred to as the ResultCube. A ResultCube is a 3-D block which is defined by the three coordinate axes. The defining of a ResultCube has been described previously.